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Cooling history and redox state of NWA 8694 chassignite: Comparison with Chassigny and NWA 2737

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NWA 8694 is a new chassignite whose constituent minerals are more Fe-rich than those in the other known chassignites (Chassigny and NWA 2737), and may suggest a petrogenetic relationship to nakhlites [1]. In this abstract we report mineralogy of NWA 8694 to infer its cooling rate and redox state, and discuss its thermal and shock history in comparison with other chassignites.

NWA 8694 is a cumulate dunite of ~2 mm olivine with interstitial pyroxene and feldspar. Olivine is homogeneous (Fo_{55-56}), but Ca decreases at the ~50-100 μm rim (0.25-0.1 wt% CaO). Because the Ca-depleted rim is narrower than those in other chassignites (~150 μm), NWA 8694 may have cooled slightly faster than the others ([2,3]: ~30 ºC/yr), but would be in the same order. Pyroxenes are low- and high-Ca pyroxenes, both exhibiting sub-micron exsolution textures (0.2-0.3 μm wide lamellae with the spacing of 0.8-1.8 μm). Although the low-Ca pyroxene host has an orthopyroxene composition ($Wo_{\sim 2}$), the EBSD analysis suggests a pigeonite structure ($P2_1/c$), which is also reported from the Chassigny pyroxene [3]. The size of exsolution texture is a bit smaller, but broadly similar to those in other chassignites, implying a similar fast cooling rate ([3]: 35-43 ºC/yr). Feldspars are isotropic (plagioclase: clustered around $An_{25}Or_{10}$, K-feldspar: $\sim An_{19}Or_{78}$), suggestive of extensive shock metamorphism, consistent with undulatory extinction of olivine. Feldspar compositions are around the equilibrium isotherm of ~800 ºC. The olivine and chromite compositions give an equilibration temperature of 760-810 ºC and $\log fO_2$ of QFM±0.3.

The inferred fast cooling rate and high fO_2 of NWA 8694 are both similar to those of Chassigny and NWA 2737 [e.g., 4], and suggest a common formation condition (e.g., thick lava flow or shallow intrusion) under oxidizing condition. The Fe-rich mineral compositions of NWA 8694 may be due to crystallization from more fractionated melt than the other chassignites. The shock degree of NWA 8694 would be similar to Chassigny, but distinct from NWA 2737 with darkened olivine showing more extensive shock.

References: [1] Hewins R. H. et al. (2015) LPSC XLVI, #2249. [2] Mikouchi T. et al. (2005) LPSC XXXVI, #1944. [3] Monkawa A. et al. (2004) LPSC XXXV, #1535. [4] Beck P. et al. (2006) GCA 70, 2127-2139.